

Make-Up Air - MUA

Mode Enable Sensor Options

The temperature of this sensor will determine if the unit is in heating, cooling or vent mode during occupied operation.

- Outside Air Temperature Sensor (MUA)

Occupied Operation

There are several ways to initiate the occupied mode of operation:

- Internal week schedule
- Remote Forced Occupied contact closure
- Pushbutton Override button on a Space Sensor (Override length is user adjustable)
- Monitoring an external Orion scheduling device

Scheduling

- Has an internal clock that provides 7 day scheduling with 2 start/stops per day.
- Allows scheduling of up to 14 holiday periods per year.

Unoccupied Operation

- The space sensor uses Night Setback Setpoints for heating and cooling calls. If Night Setback Setpoints are left at the default 30°, no Night Setback operation will occur and the unit will be off.
- Uses normal dehumidification setpoint for unoccupied dehumidification calls if Night Humidity Control is configured.
- Outdoor air damper will be closed except if unit is in unoccupied economizer free cooling mode.
- If there is no call for heating, cooling or dehumidification the unit will be in the Off Mode
- MUA unit that also has return air function, the unit can be configured to operate as a CAV unit in the Unoccupied Mode using space temperature night setbacks and/or a space dehumidification setpoint (See MUA Unoccupied Night Setback Operation section). The outside air damper remains closed. Otherwise the MUA unit will remain off in the Unoccupied Mode.

HVAC Modes of Operation

There are 5 possible HVAC Modes of Operation:

- | | | |
|----------|-------------------|------|
| *Cooling | *Dehumidification | |
| *Heating | *Ventilation | *Off |

Cooling Mode with Digital Scroll Compressor and Optional Fixed Capacity Scroll Compressors

- Cooling is enabled when the temperature at the Mode Enable Sensor rises one deadband above the Cooling Setpoint. Cooling is disabled when the Mode Enable temperature falls one deadband below the Cooling Setpoint. The setpoint and deadband are user adjustable.
- In the cooling mode, as the Supply Air Temperature (SAT) rises above the Active Supply Air Cooling Setpoint (see Supply Air Temperature Setpoint Reset section for explanation), the Digital Compressor will stage on and modulate to control to the Active Supply Air Cooling Setpoint.
- If additional cooling is required, fixed compressor stages can be staged on while the Digital Compressor continues to modulate.
- To stage up the extra compressor(s), the SAT needs to be above the Active Supply Air Cooling Setpoint and the Digital Compressor needs to be at 100% for a period of time equal to the Stage Up Delay. Once a fixed compressor is enabled the digital compressor signal will go to 10% and modulate up as needed. This will repeat as additional fixed compressors are staged up.
- For compressors to stage on, Minimum Off Times (adj.) must be satisfied as well as Stage Up Delays (adj.).
- To stage down the extra compressor(s), the SAT needs to be below the Active Supply Air Cooling Setpoint minus the Cooling Stage Control Window and the Digital Compressor needs to be at 0% for a period of time equal to the Stage Down Delay. Once a fixed compressor stages off the digital compressor will go to 100% and modulate down as needed. This will repeat as additional fixed compressors stage off.
- For compressors to stage down, Minimum Run Times (adj.) must be satisfied as well as Stage Down Delays (adj.). The digital compressor is always the last compressor to be deactivated.
- Mechanical cooling is disabled if the outdoor air temperature (OAT) falls 1° below the Cooling Lockout Setpoint and will remain disabled until the OAT rises 1° above the Cooling Lockout

Setpoint. If the OAT disables mechanical cooling while it is currently operating, mechanical cooling will stage off as minimum run times and stage down delays are satisfied.

- If the economizer is enabled it will function as the first stage of cooling (see Economizer section).
- If this is a DPAC unit, the Return Air Bypass Damper remains closed during the cooling mode.

Heating Mode:

- Heating is enabled when the temperature at the Mode Enable Sensor falls one deadband below the Heating Setpoint. Heating is disabled when the Mode Enable temperature rises one deadband above the Heating Setpoint.
- Once in the Heating Mode the unit will stage or modulate heating to maintain the Supply Air Temperature at the **Active Supply Air Heating Setpoint**. Multiple stages of heating can be configured subject to user adjustable minimum run times, minimum off times, staging up and staging down delays.
- Mechanical heating is disabled if the outdoor air temperature (OAT) rises 1° above the Heating Lockout Setpoint and will remain disabled until the OAT falls 1° below the Heating Lockout Setpoint. If the OAT disables mechanical heating while it is currently operating, mechanical heating will stage off as minimum run times and stage down delays are satisfied.

Ventilation Mode:

- This is only available in the Occupied Mode of operation on units configured for continuous fan operation and is generated anytime there is no demand for heating or cooling.

Dehumidification Mode with a Digital Scroll Compressor And Optional Fixed Compressor(s)

- In MUA applications dehumidification is enabled based on an Outdoor Air Dewpoint Setpoint. This requires an Outdoor Humidity and Outdoor Temperature sensor.
- Dehumidification can be selected as a priority mode to be active anytime the humidity is above the Indoor Humidity Setpoint, otherwise it is only available when heating and cooling demands are satisfied (Vent Mode).
- Once in dehumidification, the unit will maintain the Evaporator Coil Suction Temperature at the Coil Suction Temperature Setpoint by modulating the Digital Compressor.
- A coil suction pressure sensor is required and is typically factory installed.
- If additional dehumidification is required, fixed compressor stage(s) can be staged on. Once fixed compressor(s) are activated the Digital Compressor will only be allowed to modulate down to 70% in order to maintain reheat capacity.
- To stage up the extra compressor(s), the Evaporator Coil Suction Temperature needs to be above the Evaporator Coil Suction Temperature Setpoint and the Digital Compressor needs to be at 100% for a period of time equal to the Stage Up Delay. Once a fixed compressor is enabled the digital compressor signal will go to 70% and modulate up as needed. This will repeat as additional fixed compressors are staged up.
- To stage down the extra compressor(s), minimum run times must be met, the Evaporator Coil Suction Temperature needs to be below the Evaporator Coil Suction Temperature Setpoint minus the Cooling Stage Control Window, and the Digital Compressor needs to be at 70% for a period of time equal to the Stage Down Delay. Once a fixed compressor stages off, the digital compressor will go to 100% and modulate down as needed to maintain the coil temperature setpoint. This will repeat as additional fixed compressors stage off. The digital compressor is always the last compressor to be deactivated.
- Dehumidification Reheat is always controlled to the appropriate Active Supply Air Temperature Setpoint which will be dependent on whether you are in Heating Dehumidification, Cooling Dehumidification, or Vent Dehumidification. During Vent Mode Dehumidification the Supply Air Temperature Setpoint is calculated to be halfway between the HVAC Mode Setpoints.
- Reheat options are modulating or fixed hot gas reheat, field wired downstream duct heat, and, in certain applications, unit heat.
- Heating may also be used to supplement hot gas reheat if necessary. In this case, one form of modulating SCR Electric or Modulating HW heat or 1 stage of gas or electric heat may be used.
- **WARNING:** Using simultaneous heating and cooling cannot be approved unless the HVAC unit has been specifically designed for this purpose.

Off Mode:

- Occurs in the Unoccupied Mode when there is no heating, cooling or dehumidification demand.
- Can only occur in the Occupied Mode if the fan is configured to cycle with heating and cooling and there is no call for heating, cooling or dehumidification.

- Supply fan is off and the outside air damper is closed.

Economizer Operation

- Enabled when Outdoor Air (OA) drybulb or wetbulb temperature falls below the Economizer Enable Setpoint by 1° and the OA temperature is at least 5° below the return air temperature (if a return air temperature sensor is being used).
- Economizer operation is disabled when the OA temperature rises 1° above the Economizer Enable Setpoint.
- Wetbulb operation requires an Outdoor Humidity Sensor.
- Economizer acts as 1st stage of cooling and controls to the Active Supply Air Cooling Setpoint. If the economizer reaches 100% and the supply air temperature is still above setpoint, mechanical cooling is allowed to stage up while the economizer is held at the full open position.
- An Economizer Minimum Position can be programmed into the controller.
- Economizer Damper is closed during Unoccupied Mode, except when unoccupied free cooling is used during night setback operation.

Supply Fan Operation

- Occupied Mode – Supply fan can be configured to run continuously (default) or to cycle with heating, cooling or dehumidification.
- Unoccupied Mode – Supply fan will cycle on a call for heating, cooling or dehumidification.
- Anytime the Supply Fan is requested to start, a 1 minute minimum off timer must be satisfied. If the timer is satisfied the Supply Fan relay is activated while all other outputs are held off for a period of 1-2 minutes to purge stagnate air from the ductwork before heating or cooling occurs.
- In fan cycle mode or when going unoccupied the supply fan is held on for 2 minutes after the last stage of heating or cooling stages off.

Coil Suction Temperature Setpoint Reset

- During dehumidification the VCM will automatically reset the Coil Suction Temperature Setpoint within a $\pm 5^\circ$ range based on the space or return air humidity sensor condition rising or falling with a $\pm 5\%$ range.

MUA Unoccupied Night Setback Operation

- Normally a MUA unit will be off in the unoccupied mode.
- If the unit has return air function, night temperature setback operation and/or night humidity control can occur based on space conditions.
- Setting the temperature night setbacks to values between 0° and 29 ° will enable recirculating CAV night setback temperature controlled operation of the unit. Setting a configuration option to Unoccupied (Night) Humidity Control will enable night humidity control using the normal Indoor Humidity Setpoint.
- The Supply fan will cycle on a call for heating, cooling or dehumidification.
- These operations require a space temperature sensor and/or a space humidity sensor to be installed on the VCM-X controller.
- If no night setback operation is desired, set the temperature night setbacks to 30° (default) and/or configure the unit for No Unoccupied (Night) Humidity Control (default) and the unit will remain off during the unoccupied hours. Night temperature setback control and night humidity control operate independently.
- The outdoor air damper always remains fully closed during the Unoccupied Mode on a MUA unit.

Building Pressure Relief

This can be used to maintain a user adjustable Building Relief Pressure Setpoint (requires a Building Pressure Sensor). Available controlling output options are:

- A relay output for On/Off operation
- A 0-10VDC modulating output

There are 2 possible methods of control:

- Direct Acting, meaning that on an **increase** in building static pressure, an on/off exhaust fan can be activated or a VFD exhaust fan can be ramped up.
- Reverse Acting, meaning that on a **decrease** in building static pressure, the outside air damper can be modulated opened (makes normal economizer and IAQ economizer operation unavailable) or a supply fan VFD can be ramped up (if not in a VAV application).

Remote Forced Heating and Cooling

- These inputs (24 VAC wet contacts) allow another control system or a thermostat to force the unit into heating or cooling.
- To utilize these inputs, the heating and cooling setpoints in the VCM-X must be set to zero.
- Once in this force mode the unit will stage heating/cooling to maintain the appropriate heating/cooling leaving air setpoint until the force is removed.

Remote Forced Dehumidification

- This input (24 VAC wet contact) allows another control system or a humidistat to force the unit into dehumidification.
- To utilize this feature the humidity setpoint in the VCM-X must be set to 100%.
- Once in this force mode the unit will stage compressors to maintain the suction temperature setpoint until the force is removed.

Emergency Shutdown

- A 24 VAC wet contact input is available to be used with a N.C. Smoke Detector, Firestat, or other shutdown condition (all by others).
- If this contact opens it will initiate shutdown of the VCM-X and will generate an alarm condition. This contact closure does not produce an instantaneous shutdown.
- For instantaneous shutdown the device initiating the open condition on this contact should also be wired to cut the 24 V common to the VCM-X relay outputs.

Temperature Protection:

- Activated when the Supply Air Temperature (SAT) rises above the High Cutoff Temperature (immediate) or drops below the Low Cutoff Temperature (for 10 minutes) both of which are user adjustable. This mode shuts off the unit (with a 3 minute fan off delay) until the mode is cancelled.
- This mode is cancelled when the SAT drops 5 degrees below the High Cutoff Temperature Setpoint or rises 5 degrees above the Low Temp Cutoff Temperature Setpoint, or when the unit changes back into Occupied Operation.

Outdoor Air Lockouts

- Mechanical cooling is disabled when the Outdoor Air Temperature is below the Cooling Lockout Setpoint.
- Mechanical heating is disabled when the Outdoor Air Temperature is above the Heating Lockout Setpoint.
- For Air to Air Heat Pumps the Cooling Lockout also applies to Compressor Heating, so it will usually be a lower setting than on Cooling units that are not Air to Air Heat Pumps.

Relay Outputs

There are up to 20 output relays that are configurable for the VCM-X controller (Relay #1 is reserved for the Supply Fan and is not configurable). The configuration options are as follows:

Cooling Stages	Reversing Valve for Heat Pump Operation
Heating Stages	Economizer (Outdoor Air Damper)*
Warm up Command for VAV Boxes	Occupied*
On/Off Hot Gas Reheat	Alarm*
Preheat	Override*
On/Off Exhaust Fan (See Bldg. Pressure)	Heat Wheel (Described above)

***Relay Explanations Not Discussed Previously:**

Economizer (Outdoor Air Damper) Relay

This relay will enable if any one of the following three conditions occurs:

- The unit is configured for Economizer control and the Economizer moves 5% above its Economizer Minimum Setpoint position.
- The unit is configured as a makeup air unit (MUA), with 100% outside air, and the unit goes occupied. This condition could not occur on a CAV configured unit.
- The Hood-On contact is made (See Exhaust Hood on Operation above).

Occupied, Alarm, Override Relays

- Occupied Relay – enabled anytime the unit goes into the Occupied Mode
- Alarm Relay – enabled anytime a VCM-X alarm is active
- Override Relay – enabled anytime a space sensor pushbutton override is active

System Broadcasts

- An Outdoor Air Temperature Sensor reading and an Outdoor Air Humidity Sensor reading can be broadcast from one VCM-X controller to all other controllers on the system.

Local Loop Broadcasts

The following broadcasts can be made from a VCM-X Controller to all VAV Boxes or Zone Controllers on its loop:

- Real Time Clock information
- Supply Air Temperature
- Occupied/Unoccupied Schedule
- Main fan and heat status

Alarm Detection and Reporting

- Continuously performs self-diagnostics during normal operations to determine if any operating failures have occurred.
- These failure (alarms) can be reported to a wall mounted System Manager (requires a MiniLink Polling Device), a hand-held Modular Service Tool, the Touch Screen System Manager, or to a computer running Prism II software.
- Diagnostic LEDs on the VCM-X controller will generate “blink codes” for certain alarm conditions.

The following are the available alarm designations for the VCM-X Controller:

No Supply Sensor	Dirty Filter Alarm
Bad outdoor Air Temp	Emergency Shutdown Alarm
Space Sensor Failure	Low Supply Air Alarm
Mechanical Cooling Failure	High Supply Air Alarm
Mechanical Heating Failure	Low Control Temp Alarm
Fan Proving Alarm	High Control Temp Alarm

Trend Logging

- Continuously maintains an Internal Trend Log in memory on the controller which records a fixed set of values at a user-defined interval.
- 120 log positions (timed retrievals) are available on the controller.
- Once these positions are full, it begins overwriting the oldest data.
- Values can be retrieved using the Prism II graphical front-end software program.
- With Prism running continuously, values can be saved to the computer hard drive at regular intervals to keep from losing data.

The following are the fixed items that can be logged:

Date	Indoor Air Humidity
Time	Duct Static Pressure
Mode	Building Static Pressure
Return Air Temperature	Economizer Signal Percentage
Outdoor Air Temperature	Supply Fan VFD/Bypass Damper Signal Percentage
Supply Air Temperature	Exhaust Fan VFD/Exhaust Damper Signal Percentage
Active Supply Air Setpoint	Modulating Heat Signal Percentage
Coil Suction Temperature	Modulating Cool Signal Percentage
Outdoor Air Dewpoint	On Board Relay Status
Space Temperature	Expansion Board Relay Status
Head Pressure	Condenser Fan Signal Percentage
Outdoor Air CFM	Return Air or Space CO2
Supply Air CFM	ModGas Module Signal Percentage
	Modulating Hot Gas Reheat Module Signal Percentage

VCM-X Controller and Expansion Boards I/O Map

I/O Map

VCM-X Controller			
	Analog Inputs	Analog Outputs	Relays
1	Space temperature	Economizer	Supply Fan
2	Supply Temperature	Supply Fan VFD	Configurable
3	Return Temperature		Configurable
4	Outdoor Temperature		Configurable
5	Coil Temperature		Configurable
6	Static Pressure		
7	Space Sensor Slide Offset or Remote BAS Reset of SAT Setpoint		
VCM-X Expansion Module			
	Analog Inputs	Analog Outputs	Binary Inputs
1	Outdoor Humidity	Building Pressure VFD	Emergency Shutdown
2	Space/RA Humidity	Modulating Heating	Dirty Filter
3	Not Used	Modulating Cooling	Proof of Flow
4	Building Pressure	Return Air Damper	Remote Forced Occupied
5		Return Air Bypass Damper	Remote Forced Heating
6			Remote Forced Cooling
7			Exhaust Hood On
8			Remote Forced Dehum.
4 Binary Input Expansion Module			
	Binary Inputs		
1	Emergency Shutdown		
2	Dirty Filter		
3	Proof of Flow		
4	Remote Forced Occupied		
12 Relay Output Expansion Module			
	Relay Outputs		
1-1-2	Configurable		